

California Energy Commission
STAFF REPORT

Translating Aggregate Energy Efficiency Savings Projections into Hourly System Impacts

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ABSTRACT

This report describes the translation of aggregate energy efficiency savings projections (annual electric energy and peak demand) into 8760 hourly profiles of system impacts suitable for use in production simulation models. Two sets of energy efficiency savings were developed for years 2016 through 2026. Initially, aggregate savings for the three large California investor-owned utilities—MidBase-Mid Additional Achievable Energy Efficiency savings from the *2015 Integrated Energy Policy Report*—were translated into 8760 hourly impacts.

Subsequently, energy efficiency savings projected out to year 2030 were developed as a preliminary estimate of the statewide and utility-specific energy efficiency savings that the California Energy Commission is required to establish by Senate Bill 350 (De Leon, Chapter 457, Statutes of 2015). These aggregate energy efficiency savings were then translated into 8760 hourly system impacts using the method developed for additional achievable energy efficiency in the *2015 Integrated Energy Policy Report*.

Keywords: electricity energy savings, hourly load impacts, energy savings projections

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EXECUTIVE SUMMARY

This report describes the California Energy Commission's effort to translate additional energy efficiency savings projections beyond those embedded in baseline demand forecasts of the *2015 Integrated Energy Policy Report* into hourly system impacts. Hourly system impacts are needed for production simulation modeling and other applications which use hourly loads. Studies examining possible futures for California's electricity system have made assumptions about additional amounts of energy efficiency savings beyond those embedded within baseline demand forecasts. Frequently, a high energy efficiency scenario is examined to understand the sensitivity of results compared to other scenarios.

Although the Energy Commission Integrated Energy Policy Report process is widely used as a source for baseline demand forecasts and, in recent years, as a source for additional energy efficiency savings, modelers have been left to their own discretion to translate aggregate projections into 8760 hourly inputs required for most modern production simulation models. This effort to provide hourly 8760 system impacts for additional achievable energy efficiency savings projections is one of several now underway at the Energy Commission to provide the more detailed inputs needed by modelers.

Chapter 1 of this report focuses on developing a methodology to develop hourly system impacts from annual aggregated energy savings needed for production simulation modeling. This methodology was implemented for the additional achievable energy efficiency savings projections prepared as part of the *2015 Integrated Energy Policy Report*. Additional achievable energy efficiency savings represent a continuation of "business as usual" program activities of utilities in offering voluntary programs and the Energy Commission in developing mandatory standards. Adjusting the baseline Energy Commission demand forecast without additional achievable energy efficiency savings by including these savings results in a "managed" demand forecast that the California Independent System Operator and the California Public Utilities Commission use in electricity planning studies and procurement activities.

Chapter 2 of this report describes the methodology and results of a slight extension of the additional achievable energy efficiency approach to develop hourly projections of energy efficiency targets consistent with Senate Bill 350 (De Leon, Chapter 457, Statutes of 2015), which are considerably higher than the projections reviewed in the *2015 Integrated Energy Policy Report* proceeding. As California evolves toward reliance upon preferred resources, the impact of high levels of projected energy efficiency savings must be examined using system studies. For production simulation modeling, expressing Senate Bill 350 energy efficiency targets in hourly form is essential to fully understanding the implications of reaching such targets on overall electric system operations, fuel use, and greenhouse gas emissions.

CHAPTER 1:

Additional Achievable Energy Efficiency Savings Projections

Background

As part of the *2009 Integrated Energy Policy Report (2009 IEPR)* proceeding, the California Energy Commission developed energy savings projections that went beyond the energy efficiency savings embedded within baseline demand forecasts. Baseline demand forecasts have commonly used conservative criteria to define committed program activities from utility programs, appliance and building standards, and other program activities. Only committed program impacts and naturally occurring energy efficiency savings are included in baseline demand forecasts.

In the 2008 Long-Term Procurement Plan (LTPP) rulemaking, California Public Utilities Commission (CPUC) staff introduced “managed” demand forecasts, which augmented baseline demand forecasts with increased energy efficiency and other demand-side impacts. Following publication of the CPUC’s *2008 Energy Efficiency Goals Update Report* and the *2009 IEPR*, staff focused on determining the aggregate annual energy and peak demand impact of energy efficiency savings included in the CPUC’s *report* that were incremental to the savings embedded in the *2009 IEPR* demand forecasts.

The initial goal was to identify savings projections from “incremental uncommitted energy efficiency” that could be counted separately from projected energy efficiency savings already included in demand forecasts. This goal remained over several IEPR and LTPP proceedings; however, terminology shifted from “incremental uncommitted energy efficiency” to “additional achievable energy efficiency” (AAEE) savings. Scenarios were developed that hypothesized adoption of different strengths of policy initiatives. Senate Bill 350 (SB 350) (De Leon, Chapter 457, Statutes of 2015) is expected to result in further changes in how incremental energy savings included in baseline demand forecasts are developed and used for electricity planning purposes.¹

Once a process for developing AAEE savings projections was established, efforts turned to translating annual peak demand savings into load bus impacts for use by the California Independent System Operator (California ISO) in power flow modeling studies. Such studies require great geographic granularity to simulate power generation and its flows through the transmission system to the load of end-users. An initial effort to accomplish this translation was part of the reliability study of Southern

¹ SB 350 establishes, among other changes intended to enable 40 percent reduction of GHG emissions from the electricity sector, a mechanism that is expected to double expected energy efficiency savings compared to previous goals by year 2030.

California mandated by Assembly Bill 1318 (AB 1318) (Perez, Chapter 285, Statutes of 2009).² AB 1318 directed that demand-side measures be considered and required an innovative look at how demand-side savings projections could be accurately modeled in transmission studies using power flow techniques. Energy Commission staff developed a method of allocating aggregate service area peak demand savings to the level of load busses commonly used in power flow modeling by major California utilities and the Western Electricity Coordinating Council. Such translations of aggregate AAEE savings projections to load bus system impacts have been undertaken in four annual California ISO transmission planning cycles, and protocols have been established governing which AAEE scenario is to be used in transmission studies for specific purposes.³

The need to translate aggregate AAEE savings projections into hourly system impacts has become more evident with the creation of flexible resource procurement requirements. Such requirements are now a feature of the short term resource adequacy program implemented by the CPUC and California ISO for all load serving entities within the California ISO balancing authority area (BAA). Such flexible resource requirements start with analyses to determine projected ramping requirements over specified time intervals for the California ISO as a whole. As implemented, ramping requirements are established for each month of the year.⁴ Participants noted that AAEE savings, although modest in the short term (1 to 2 years) compared to the long-term (10 years), could affect three-hour ramping requirements—the metric used to define flexible resource requirements. The California ISO agreed to modify its translation of AAEE aggregate savings into hourly impacts if the Energy Commission could create a more analytically correct alternative set of projections. Thus, the effort was born.

Modeling Approach

In September 2015, Energy Commission staff proposed a spreadsheet-based tool that would translate aggregate annual AAEE energy savings into hourly system impacts for each of the investor-owned utility service areas within the California ISO balancing authority area. There are numerous publicly owned utilities (POU) within the California ISO BAA for which no aggregate AAEE projections were available. The load of these POUs is only about 6 percent of the total electric consumption within the California ISO BAA. The larger POUs (LADWP and SMUD) are located in separate balancing authority areas and the details of their loads do not affect California ISO planning studies to any appreciable degree.

2 ARB, Assembly Bill 1318: Assessment of Electrical Grid Reliability Needs and Offset Requirements in the South Coast Air Basin, <http://www.arb.ca.gov/energy/esr-sc/esr-sc.htm>.

3 http://docketpublic.energy.ca.gov/PublicDocuments/15-IEPR-01/TN210527_20160224T115023_2015_Integrated_Energy_Policy_Report_Small_Size_File.pdf, p. 144.

4 <http://www.caiso.com/Documents/FinalFlexibleCapacityNeedsAssessmentFor2017.pdf>.

Aggregate AEE savings are derived from an ongoing CPUC-sponsored effort to developed projections of 10-year forward energy efficiency potential.⁵ Efficiency measures that satisfy technical, economic, and market potential screens are further adjusted to exclude efficiency savings already embedded within baseline demand forecasts. The residual is termed “additional achievable energy efficiency,” because it is additional with respect to a specific baseline demand forecast.

Developing hourly load impacts of AEE requires consideration of the individual measure savings within the model that Navigant developed to prepare potential and goals projections for the CPUC and the adjustments to its projections made by Energy Commission staff to avoid double counting with savings already included within Energy Commission baseline demand forecasts. It became clear that the expertise of the Navigant team would be useful to clarify the measure-level details of their potential and goals model, and to identify available load shapes for measures.⁶

Identifying Important Measures

Staff assessed which measures made the largest contribution to aggregate energy savings by using the Use-Category tab of the Navigant Viewer that was developed during CPUC’s energy efficiency potential and goals proceeding.⁷ Navigant staff repeated this effort subsequent to the adjustments that convert potential energy efficiency savings into AEE savings.

AEE savings by use-category was selected as the level of disaggregation—more granular than the customer sector, but not as granular as the efficiency measure. Staff reviewed the data, with input from Navigant, and settled upon 19 specific use-categories across the six customer sectors. For example, commercial lighting is the largest use-category. Where there were additional use categories that were not significant individually, such savings were grouped into an “other” category for each customer sector. Neither mining nor street lighting had any secondary use categories.

To illustrate, **Table 1** lists the annual electricity savings for the Southern California Edison (SCE) service area by the final set of 19 sector/use categories for two future years. **Table 1** shows that some specific customer sector/use category combinations are more important than others. Further, the customer sector mix shifts toward the commercial sector over time. As discussed below, this shift has important ramifications for the results.

The Energy Commission/Navigant team decided that the use-category savings activities had enough in common between IOU programs, appliance and building

5 The CPUC uses skilled contractors to develop energy efficiency potential studies. The current consulting firm—Navigant Consulting, Inc.—has provided services to the CPUC for the 2013 and 2015 cycles of analyses. For the 2015 project, see <http://www.cpuc.ca.gov/WorkArea/DownloadAsset.aspx?id=4033>.

6 The CPUC agreed to make Navigant available to the Energy Commission through their existing contract.

7 <http://www.cpuc.ca.gov/general.aspx?id=2013>.

standards, and emerging technologies that all of the program sources of use-category savings could be pooled together. The alternative would have created 2-3 times more use-categories and finding appropriate load shapes for such a large set was not feasible given the time and budget.

Table 1: Illustration of Customer Sector/Use Category Mix of AAEE Savings for SCE

Sector	Use Category	2020		2026	
		Annual (GWh)	Percent of total	Annual (GWh)	Percent of total
Residential	AppPlug	438.69	10.4%	866.96	10.0%
Residential	HVAC	210.67	5.0%	382.54	4.4%
Residential	Lighting	524.90	12.5%	771.89	8.9%
Residential	SHW	121.73	2.9%	248.47	2.9%
Residential	WholeBlg	138.85	3.3%	287.34	3.3%
Residential	Other	2.99	0.1%	9.27	0.1%
Commercial	ComRefrig	179.88	4.3%	394.25	4.6%
Commercial	Lighting	1258.10	29.9%	2645.01	30.6%
Commercial	WholeBlg	365.43	8.7%	1235.90	14.3%
Commercial	Other	402.79	9.6%	680.39	7.9%
Industrial	HVAC	25.21	0.6%	54.27	0.6%
Industrial	Lighting	119.13	2.8%	271.57	3.1%
Industrial	MachDr	175.82	4.2%	382.41	4.4%
Industrial	Other	15.71	0.4%	34.52	0.4%
Mining	OilGasExtract	31.85	0.8%	48.26	0.6%
Agricultural	MachDr	49.80	1.2%	110.11	1.3%
Agricultural	ProcRefrig	11.34	0.3%	25.08	0.3%
Agricultural	Other	1.56	0.0%	3.50	0.0%
Street Lighting	Stl	128.85	3.1%	192.48	2.2%
Total		4203.30	100.0%	8644.22	100.0%
Residential		1437.83	34.2%	2566.47	29.7%
Commercial		2206.21	52.5%	4955.54	57.3%
Industrial		335.87	8.0%	742.78	8.6%
Mining		31.85	0.8%	48.26	0.6%
Agricultural		62.69	1.5%	138.69	1.6%
Street Lighting		128.85	3.1%	192.48	2.2%

Source: California Energy Commission, Energy Assessments Division

Developing Use-Category Shapes

Three types of shapes were required for the 8760 hourly projection tool:

- (1) Named use-categories;

- (2) The “other” group pooling together several small use categories within a customer sector; and
- (3) The hourly transmission and distribution loss factor needed to translate from customer savings to system impacts.

Named Use-Categories

Acquiring use-category load shapes to translate annual energy to 8760 hourly savings was more challenging than expected. The Database for Energy Efficient Resources body of deemed measure data did not provide a sufficient set of use-categories to cover the named use-categories listed in **Table 1**.⁸ Navigant researched available sources of energy efficiency savings data and developed a set of use-category shapes. In selecting which measure-specific shape, Navigant attempted to choose a shape that best represented the composite energy impacts of all measures pooled into that sector/use category bucket. This was clearly a judgmental exercise.

Attachment I provides a detailed discussion of Navigant’s efforts to acquire representative shapes for the named use-categories.

Sectoral Residuals

Most customer sectors have a residual composed of use-categories that are too small to model separately. Since these residuals are generally a composite of multiple use-categories, and several efficiency measures fall within each use-category, no one measure profile is likely to accurately reflect this composite. Staff chose to use a customer sector profile derived from the Dynamic Load Profiles (DLP) that each IOU is required to prepare for each calendar day in support of electricity service provider direct access transactions.⁹

DLPs are profiles that replicate the total load of a customer sector for each hour of each day of the year, so while these may be distinct from the impacts of a specific efficiency measure, when applied to many efficiency measures within a customer sector it should be a reasonable profile. Since data for 2013 was the source for named use-category load profiles, DLP data from 2013 was acquired and converted for use in the spreadsheet tool.

Hourly Transmission and Distribution Loss Factors

The aggregate AAEE savings projections are at the end-user level, e.g., without any transmission or distribution losses. Hourly losses can vary across the day, so

⁸ The Database for Energy Efficient Resources is an Energy Commission and CPUC sponsored database designed to provide well-documented estimates of energy and peak demand savings values, measure costs, and effective useful life all with one data source.

⁹ DLP source for Pacific Gas and Electric is <http://mads.pge.com/>. The DLP source for SCE is <https://www.sce.com/wps/portal/home/regulatory/load-profiles/dynamic-load-profiles/>.

Distribution Loss Factor data for 2013 was acquired.¹⁰ There are several voltage choices included in this data, and since most end-user savings are found in residential and commercial sectors, staff chose to use secondary distribution voltage loss factors.

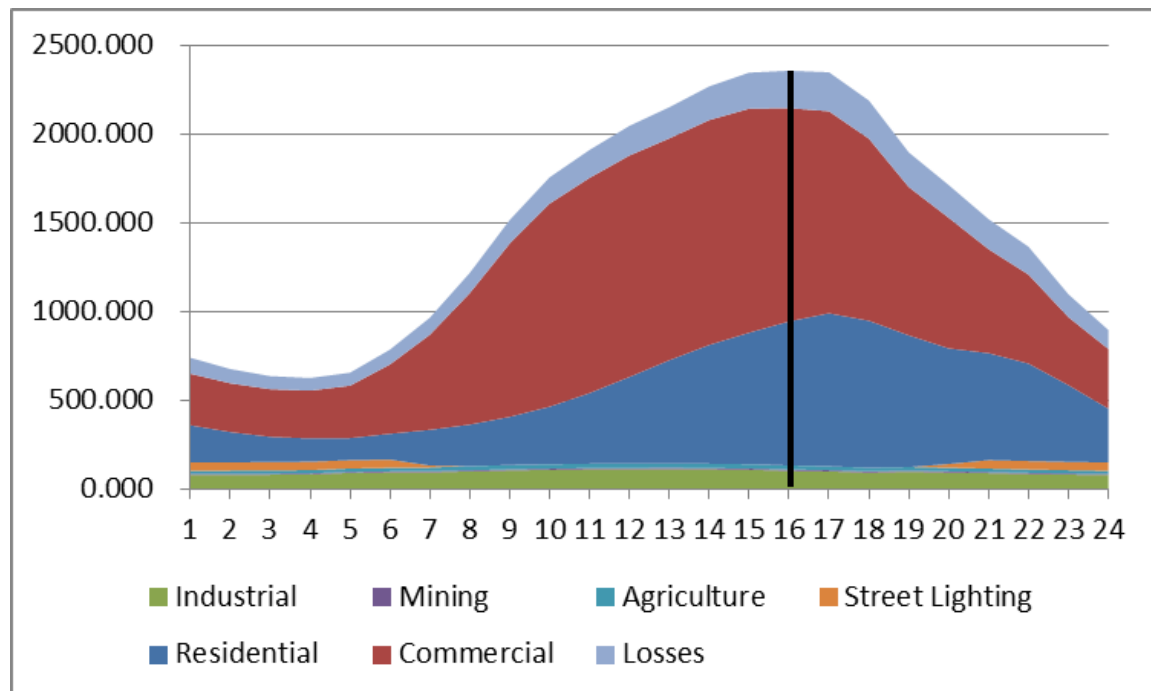
Finally, transmission losses need to be added to distribution losses to scale end-use savings to full system impacts for use in production simulation modeling. Staff relied upon previous estimates that PG&E and SDG&E systems have a 3 percent transmission loss factor, while SCE has a 2.5 percent transmission loss factor.

MidBase-MidAAEE Results

The results discussed below are from the MidBase-MidAAEE case, but the general observations are common to all of the AAEE cases.¹¹

Figure 1 provides the projected hourly loads for the six SCE customer sectors, and the total losses that make the distinction between end-user savings and system impacts, for the day in year 2026 with maximum projected impacts. The maximum value occurs

Figure 1: SCE Hourly Loads by Customer Sector on the Day in 2026 (September 6) with Maximum Projected Impacts (MW)



Source: California Energy Commission, Energy Assessments Division

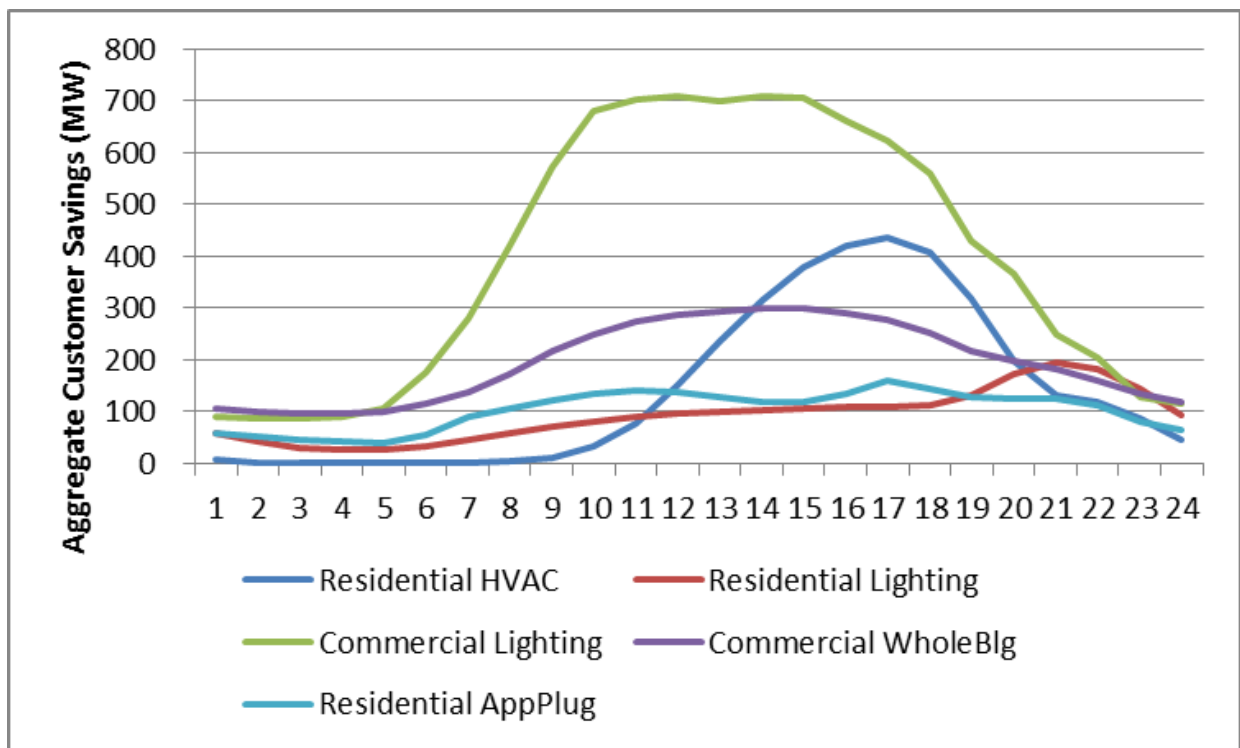
10 Historic Dynamic Load Profiles and Distribution Loss Factor data for prior years for SDG&E is not posted, but SDG&E made such data available in response to a request.

11 The 2015 IEPR demand forecast has three baseline cases (high, mid, and low) and five AAEE cases (high, high-mid, mid, low-mid, and low). A specific one of these 15 combinations is described by its baseline parent and AAEE variant, thus MidBase-MidAAEE refers to a baseline forecast with mid econ/demo drivers and midAAEE savings characteristics.

in hour 1600 although the aggregate values for hours 1500 and 1700 are nearly identical. The commercial sector is the largest contributor with residential being the second largest. Losses are the third most important component.

Figure 2 plots the hourly results for the SCE service area of the five largest use-category savings for the day with maximum projected impacts (the same day as **Figure 1**). Each use-category has a unique shape that matches previous understanding of the impacts of such measures. As noted, commercial lighting is the largest use-category for most hours of the day. Residential lighting savings peak in hour 2100, which is later in the day than any other use-category.

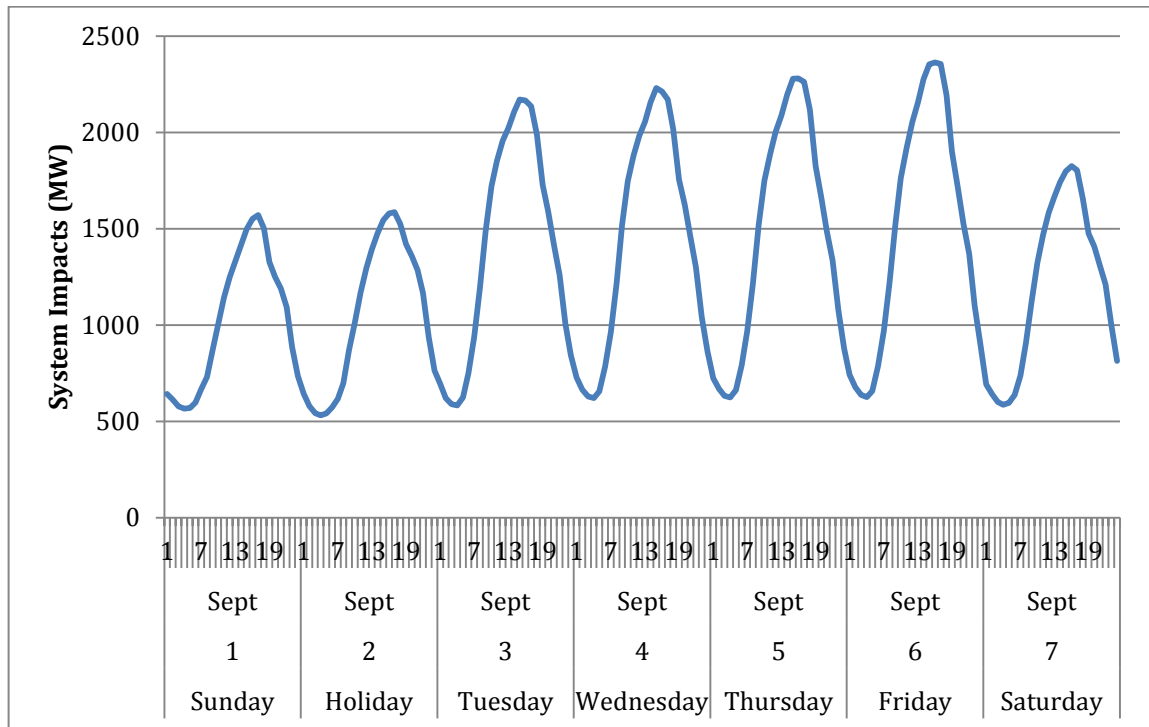
Figure 2: Hourly Results for the Five Largest Use-Categories in SCE Service Area for Year 2026



Source: California Energy Commission, Energy Assessments Division

Figure 3 shows aggregate AAEE system impacts (customer savings plus losses) for the SCE service area in year 2026 for the week in which highest projected system impacts occur (September 1-7). Note the strong day of week influences with Saturday, Sunday, and a Monday holiday (Labor Day 2013) with mid-afternoon impacts much lower than other days. However, early morning trough values (hours 4 and 5) are nearly identical for all days. Users of the hourly results need to resequence these impacts to match the day of the week for the year that is being forecasted so that data from different sources is not mixed without proper time synchronization.

Figure 3: Aggregate AAEE System Impacts for SCE for September 1-7, 2026 (MW)



Source: California Energy Commission, Energy Assessments Division

Comparison to AAEE Peak Savings Results

Hourly savings were generated from the AAEE energy savings projections. How do these results compare to the peak values reported for the AAEE analyses?¹² Once the basic projection tool was developed and results were obtained, Energy Commission and Navigant staff explored this question in depth.

In the CPUC-funded report *Energy Efficiency Potential and Goals Study for 2015 and Beyond: Stage 1 Final Report*,¹³ peak savings values are determined by applying peak to energy ratios that convert annual energy savings for a measure into peak hour savings for that measure.

These values are derived from energy efficiency Evaluation Measurement & Verification studies. A protocol has been established by which such values are determined by averaging the impacts of the three hottest sequential days for a specific range of afternoon hours for each climate zone. So the values resulting from this protocol are non-coincident in the sense of geographic areas adding up to a complete IOU service area. The 8760 hourly tool has no geographic subareas so there is no coincidence issue. Further, since the hourly values for the three IOU service areas can be added to

¹² http://www.energy.ca.gov/2015_energypolicy/documents/2015-12-17_additional_aee.php.

¹³ See <http://www.cpuc.ca.gov/WorkArea/DownloadAsset.aspx?id=4033>.

develop a California ISO-wide balancing authority area system impact, any non-coincidence issues among the IOU service areas are automatically avoided in using hourly projections.

As described in Attachment I, Navigant concluded that the “official” peak values for AAEE savings reported by the Energy Commission in the formal *2015 IEPR* proceeding are no more reliable than the results of applying the use-category hourly profiles to annual energy to obtain use-category hourly results that can be added together hour by hour.

Conclusions

The results of the 8760 AAEE load projection project have been provided to the CPUC and California ISO for use in studies in which hourly values are needed for energy efficiency savings beyond those embedded in the baseline *2015 IEPR* demand forecast. Previous methods of translating AAEE aggregated savings had disadvantages over the new method, including:

- Subtracting AAEE aggregate energy from baseline energy and AAEE peak savings from baseline peak demand forecasts and then applying a historic shape misses the changing mix of savings across customer sectors. It also misses the emphasis on residential and commercial sectors in AAEE savings, with very different contributions to system demand than the overall baseline demand with industrial, agricultural, and other smaller customer sectors.
- Using energy efficiency shapes from earlier studies cannot match the specificity of this new method with the actual mix of AAEE savings by use categories from the *2015 IEPR* analyses.

Further improvement could be made by pooling similar measures used by all program types into a single use-category for a customer sector; however, this may mask differences at the measure level in the profile of savings from individual program types. For example, the daily savings profile of a lighting impact from day lighting design achieved in a new building as a result of Title 24 Building Standard is unlikely to match the hourly profile of savings from installing a more efficient lamp in an existing receptacle. Selective development of additional savings profiles, where such distinctions are important, would be useful without excess time and effort to develop needed shape data.

The effort to develop 8760 hourly system impacts is expected to improve analyses that require hourly impacts of future energy efficiency savings. Production simulation modeling, widely used in the industry, will have improved data to include in system studies. Studies that seek to understand how hour to hour variations in load influence the amount and type of flexible resources to operate the electricity system, such as California ISO studies of flexibility requirements, may be directly affected by these hourly system impact projections.

CHAPTER 2:

Developing Senate Bill 350-Friendly Energy Efficiency Targets and Associated Hourly Impacts

Background

SB 350 (De Leon, Chapter 457, Statutes of 2015)¹⁴ establishes new/expanded energy system targets as steps toward major reductions in GHG emissions by 2030.¹⁵ Projected energy efficiency savings previously established as goals in the *2014 Integrated Energy Policy Report Update (2014 IEPR Update)* are to be doubled as long as they are feasible and cost-effective.

The Energy Commission, in consultation with the CPUC, is to establish energy efficiency targets by November 2017. At the time of this report, that effort is not yet complete. Electric system studies require preliminary projections that can be used to study the impact of this and other elements crucial to the electricity system. This chapter documents how aggregate SB 350-Friendly annual energy and peak demand savings were developed, and discusses the translation of these aggregate savings projections into hourly system impacts.

Methodology

Developing specific numeric projections of the 8760 hourly system impacts of energy savings consistent with the implementation of SB 350 requires establishing aggregate savings comparable to those prepared as AAEE savings; and determining whether such aggregate savings would have a different load shape than the AAEE hourly system impacts discussed in Chapter 1.

Aggregate Projections of Senate Bill 350-Friendly Savings

Aggregate savings must be developed before SB 350-Friendly energy efficiency hourly system impacts can be developed. Since such projections have not yet been finalized by the Energy Commission, an approximation was prepared earlier this year and provided to the CPUC for review. **Table 2** reports the statewide results.

Energy Commission staff started with the *2015 IEPR* MidBase-MidAAEE projections for the three IOU service areas, and recognized that two modifications needed to be made.

14 SB 350 establishes, among other changes intended to enable 40 percent reduction of greenhouse gas emissions from the electricity sector, a mechanism that is expected to double expected energy efficiency savings compared to previous planning expectations by year 2030.

15 http://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201520160SB_350.

First, values from 2027 to 2030 were created by extending the 2026 AAEE value at a 3 percent per year annual growth rate (2026 was the last year for which AAEE projections were available). Second, these annual energy values have been scaled up by a factor that reaches two in year 2030, e.g., doubling is achieved by year 2030. No increase above the original AAEE values were assumed until 2018, since statewide and utility-specific targets are not expected to be established until late 2017.

Table 2: Annual Aggregate Energy Efficiency Projections (GWh)

		2015 IEPR			SB 350 Projections	
Year		Original MidAAEE	Extended to 2030		Scaling Factor	SB 350 Annual Amount
2016		1,750	1,750		1.000	1,750
2017		3,581	3,581		1.000	3,581
2018		5,789	5,789		1.077	6,234
2019		7,385	7,385		1.154	8,521
2020		8,838	8,838		1.231	10,877
2021		10,432	10,432		1.308	13,642
2022		11,966	11,966		1.385	16,568
2023		13,554	13,554		1.462	19,809
2024		15,076	15,076		1.538	23,194
2025		16,600	16,600		1.615	26,815
2026		18,128	18,128		1.692	30,678
2027		na	18,672		1.769	33,034
2028		na	19,232		1.846	35,505
2029		na	19,809		1.923	38,094
2030		na	20,403		2.000	40,806

Source: California Energy Commission, Energy Assessments Division

The MidBase-MidAAEE case from the 2015 IEPR was used rather than the 2014 MidAAEE case from the 2014 IEPR Update because key analytic assumptions used in the 2014 AAEE analyses were corrected in the 2015 AAEE analyses. Discounting these changes would have distorted the aggregate system load impacts had they been used as the foundation for hourly analyses. Energy Commission staff communicated these results and an explanation of the method to CPUC staff in early 2016. The CPUC chose

to include this set of SB 350-Friendly projections within the final 2016 LTPP Assumptions and Scenarios document, issued by CPUC President Michael Picker on May 17, 2016.¹⁶ These staff projections replaced an earlier set of projections developed by CPUC staff.

Hourly Projections of SB 350-Friendly Energy Efficiency Savings

Although four methods of developing the hourly impacts of high energy efficiency projections exist, all had strengths and weaknesses as summarized below.

- Simple scaling of the *2015 IEPR* midBase-MidAAEE case results:
 - Simplistic, but minimal resources to implement
- The *2015 IEPR* MidBase-HighAAEE case:
 - Only about 13 percent higher than the MidAAEE case
 - Requires developing a new sectoral/use-category data set formatted for use in the hourly projection tool
- Analyses undertaken by Navigant Consulting in support of the CPUC's implementation of Assembly Bill 802 (AB 802) (Williams, Chapter 590, Statutes of 2015):
 - No public documentation was available at the time of this analysis. Navigant reported only a limited increase in aggregate savings when "existing baseline" measures were examined using the measure set developed for the 2015 Potential and Goals modeling effort
 - Assisting the Energy Commission in developing SB 350 implications would have reduced the time available to assist the CPUC Energy Division in completing a report on AB 802¹⁷
- Consult with Navigant about sector potential using technical and/or economic potential not cost effective through market mechanisms in the 2015 Potential and Goals study:
 - Violates SB 350 energy efficiency target requirements that utility-specific targets be feasible and cost-effective
 - Navigant staff lacked sufficient time to complete an AB 802 report

Energy Commission staff chose simple scaling. For each projection year, the annual scaling factors shown in **Table 2** were used to scale up the *2015 IEPR* MidBase-MidAAEE hourly results to obtain SB 350-Friendly EE hourly results. This method

¹⁶ <http://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M162/K005/162005377.PDF>.

¹⁷ Navigant Consulting, Inc. <http://www.cpuc.ca.gov/General.aspx?id=2013>.

implies the unlikely conclusion that the percentage mix of energy efficiency measures in each future year is identical in the MidBase-MidAAEE projections as well as the SB 350-Friendly EE projections.

SB 350-Friendly Results

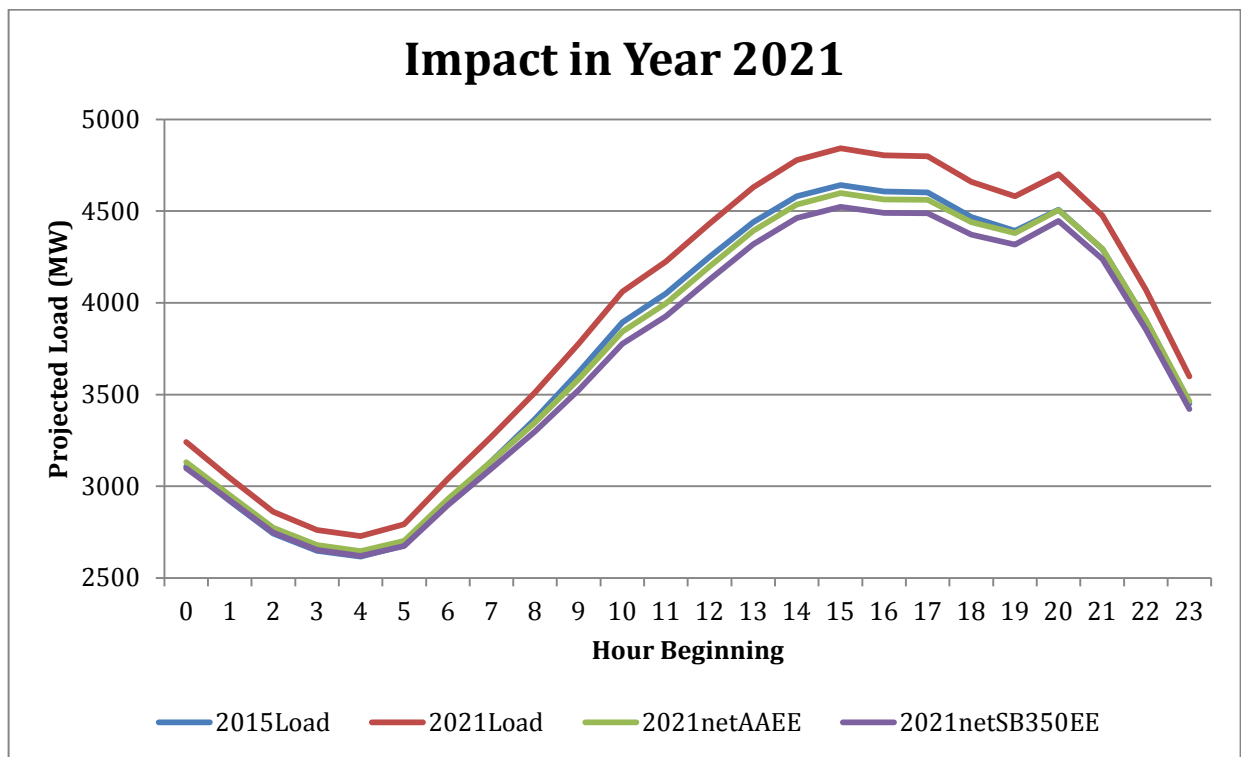
In terms of hourly values, the Results section of Chapter 1 is applicable to the SB 350-Friendly energy efficiency projections. Since the relationship among the sectors and the measures included in the midBase-midAAEE hourly projections are the same for the SB 350-Friendly projections the shapes shown in **Figures 1, 2, and 3** are illustrative.

The results of scaling 2015 *IEPR* MidBase-MidAAEE up to obtain an SB 350-Friendly energy efficiency projection reveal interesting impacts on the overall load shape and peak hour. Although the Energy Commission has not made an official hourly projection of its baseline forecast, staff is undertaking analyses to reveal the impact of several important factors –including high levels of energy efficiency. To evaluate whether hourly load shape changes might emerge from increases in energy efficiency savings, staff developed a simple analysis based on scaling up 2015 recorded loads and then subtracting the midAAEE or SB 350-Friendly energy efficiency to obtain “managed” load forecast¹⁸ under SB 350-Friendly energy efficiency conditions.

Figure 4 shows results for 2021 for the SDG&E service area. The 2015 *IEPR* MidBase-No AAEE peak demand forecast for SDG&E increases only 4.3 percent from 2015 to 2021, so this factor was used to scale up recorded 2015 hourly loads to year 2021 for the day that was the 2015 peak in the SDG&E service area. This is shown as the line labeled 2021Load. The 2021netAAEE line shows the impact on system hourly load shape of subtracting the MidAAEE hourly results from the 201Load line to obtain this possible future. The 2021netSB 350EE line shows the impact of using the higher level of energy efficiency savings from the SB 350-Friendly projections for the SDG&E region. To the eye, these two futures have more load reduction in afternoon hours than the secondary peak at hour beginning 20, but not enough to shift the hour of service area peak load.

¹⁸ A “managed” load forecast is the baseline load forecast adjusted down for the impact of an AAEE savings case.

Figure 4: Impacts on SDG&E Peak Day Load Shape in 2021

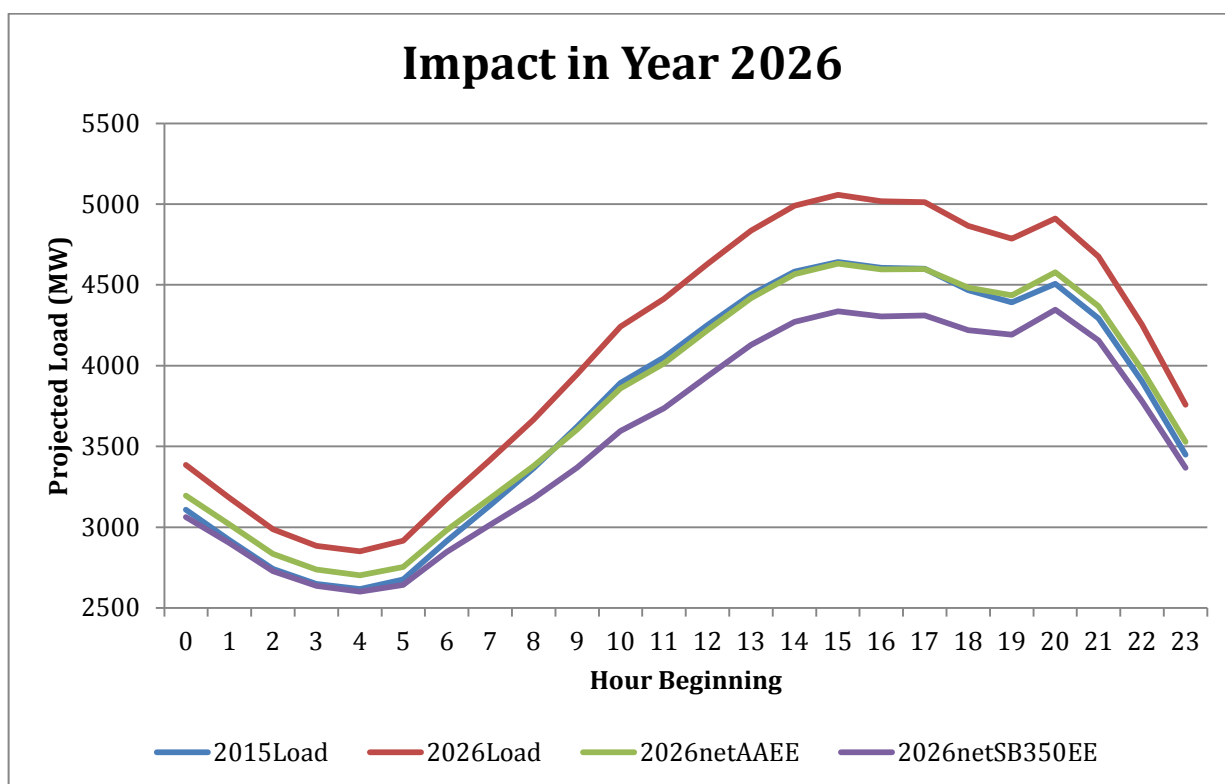


Source: California Energy Commission, Energy Assessments Division

Figure 5 repeats this same analysis for SDG&E, but for 2026. The greater number of years to pursue higher levels of energy efficiency savings effort is continuing to reduce afternoon loads more than evening loads, so in the 2026netAAEE line the eye cannot really tell whether peak occurs in the afternoon or the evening. In the 2026netSB 350EE case, the peak has clearly shifted from hour beginning 15 to hour beginning 20. In effect, the secondary peak at hour 20 has become the primary peak by 2026, and the primary peak at hour 15 has become the secondary peak. This change in peak hour has minimal impact on the *level* of the peak, but could have dramatic impact on the mix of resources needed to satisfy a peak that occurs as late as hour beginning 20. Such a change would mean that central station solar PV generating resources would have a negligible contribution to satisfying this evening peak load.

As shown in Table 1 and Figure 2, the customer sector with the largest AAEE savings is commercial and these savings are concentrated in the hours of traditional business activity. These savings begin to diminish around hour beginning 15. Even residential sector savings that peak at hour beginning 17 or 18 are diminishing strongly thereafter. Figure 1 showed that aggregated savings at hour beginning 20 are at least one-third lower than the maximum on a summer weekday.

Figure 5: Impacts on SDG&E Peak Day Load Shape in 2026



Source: California Energy Commission, Energy Assessments Division

Although this analysis is limited to SDG&E service area, the high levels of energy efficiency savings that target the commercial sector will likely produce similar effects in all service areas.¹⁹

Conclusions/Observations

The results of this 8760 SB 350-Friendly energy efficiency load projection project have been provided to the CPUC and California ISO for use in proceedings in which hourly values are needed. The Assigned Commissioner Ruling issued by CPUC President Michael Picker in R.13-12-010 directs that modeling studies use the 8760 hourly projections developed by the Energy Commission staff.²⁰

Two elements of this analysis are worth emphasizing here:

- Although there is no basis for assuming that aggregate SB 350-Friendly energy savings as developed by the Energy Commission will match the eventual targets

¹⁹ Although this analysis does not take behind the meter solar photovoltaic growth into account in suggesting load shape changes, adding this effect would further diminish early and mid-afternoon loads with little to no impact on loads after hour 18. Adding this behind the meter effect would likely accelerate the year in which these peak hour shifts take place.

²⁰ CPUC Picker ACR, May 17, 2016, p. 8.

formally established by the Energy Commission in late 2017, such projections express a high energy efficiency target and can be useful in planning studies to identify consequences.

- Developing 8760 load shapes reveals the need for detailed specification of the mix of energy savings in an SB 350 energy efficiency future since there is a range of hourly patterns among possible energy efficiency measures. Future efforts to develop SB 350 energy efficiency targets need some detailed understanding of the likely mix of measures that will be used by utilities to reach the targets.

The observations about possible improvements to methods in the Chapter 1 Conclusions also apply here. What is more critical is that SB 350 energy efficiency targets be developed with an explicit mixture of sectoral and use-category savings. If it is unknown how utilities will comply, then multiple SB 350 cases may be needed so that impact assessments on the electricity system are not misinformed about the uncertainties involved in *how* these targets could be achieved, as distinct from *whether* they will be achieved.

From an annual energy perspective, alternative approaches for satisfying an annual goal could be equally plausible. From the 8760 hourly system impact perspective, however, each of these methods would probably have a separate, unique hourly pattern. For those studies that are driven by hourly system impacts, the uncertainties of *how* are just as important as *whether* impacts will be realized.

ACRONYMS

Acronym	Proper Name
<i>2015 IEPR</i>	<i>2015 Integrated Energy Policy Report</i>
AB 1318	Assembly Bill 1318
AB 802	Assembly Bill 802
AAEE	additional achievable energy efficiency
BAA	Balancing authority area
California ISO	California Independent System Operator
CPUC	California Public Utilities Commission
Energy Commission	California Energy Commission
GWh	gigawatt
IEPR	Integrated Energy Policy Report
IOU	Investor-owned utility
LADWP	Los Angeles Department of Water and Power
LTPP	Long-Term Procurement Plan
MW	Megawatt
PG&E	Pacific Gas and Electric Company
POU	Publicly owned utilities
SB 350	Senate Bill 350
SCE	Southern California Edison Company
SDG&E	San Diego Gas & Electric Company

ATTACHMENT I: Energy Efficiency Potential and Goals Study for 2015 and Beyond

Please Note: This document is an attachment to a report prepared/funded by the California Energy Commission. The Energy Commission did not prepare or fund this attachment, but the Navigant Consulting, Inc. (Navigant) has requested it be available as a supporting document.

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